

THE OCCURRENCE OF GRAPTOLITES NEAR YASS, NEW SOUTH WALES.

By KATHLEEN SHERRARD, M.Sc., and R. A. KEBLE, F.G.S., Palaeontologist to the National Museum, Melbourne.

(Plate xv; twenty-five Text-figures.)

[Read 27th October, 1937.]

Graptolites of both Upper Ordovician and Silurian age have been found near Yass. Upper Ordovician assemblages were discovered in slates at several localities in the Parishes of Morumbateman, Mundoonen and Manton in the Yass River District, all situated between 12 and 15 miles east of Yass and near the Yass-Gundaroo road (Sherrard, 1936*b*). These graptolites of Upper Ordovician age were found in rocks hitherto mapped as Silurian, which age was probably assigned to them on account of their comparative proximity to beds carrying Silurian fossils near Yass. No other fossils were found with the graptolites.

Silurian graptolites occur at a locality known as Silverdale, seven miles to the north-west of Yass (see Text-fig. A), where several species of *Monograptus* have been obtained (Sherrard, 1934, 1936*a*). All were found in one small outcrop, which also yielded brachiopods, crinoid stems and traces of trilobites.

Upper Ordovician Beds.

These beds are blue and grey shaly slates, all dipping at high angles, 50 degrees and more, and striking between north-west and west-south-west. The slates cleave easily, but have not the fissile cleavage of roofing slates. In some cases they are puckered and contorted, while in others mineral solutions have penetrated freely along the bedding planes, probably often obscuring graptolites. In some specimens the material of which the graptolite impressions consists has been dissolved away, leaving merely an unidentifiable negative impression, surrounded by a white film.

The graptolites found at the various localities are:

Loc. 1.—Portion 24, Parish of Morumbateman, on Yass-Gundaroo road, 100 yards west of 12th mile-post: *Climacograptus bicornis* Hall, *C. missilis* Keble and Harris, *Diplograptus (Orthograptus) calcaratus* Lapworth.

Loc. 2.—Portion 1, Parish of Mundoonen, 200 yards north of Morumbateman road junction: *Diplograptus (Orthograptus) calcaratus* Lapw. var. *basilicus* Lapw., *D. cf. truncatus* Lapworth, *D. sp. indet.*, *Climacograptus missilis* Keble and Harris, *C. sp. indet.*, *Cryptograptus tricornis* Carruthers, *Retiograptus yassensis*, n. sp., *Dicellograptus cf. complanatus* Lapworth, *D. cf. sextans* Hall, *D. sp. indet.*

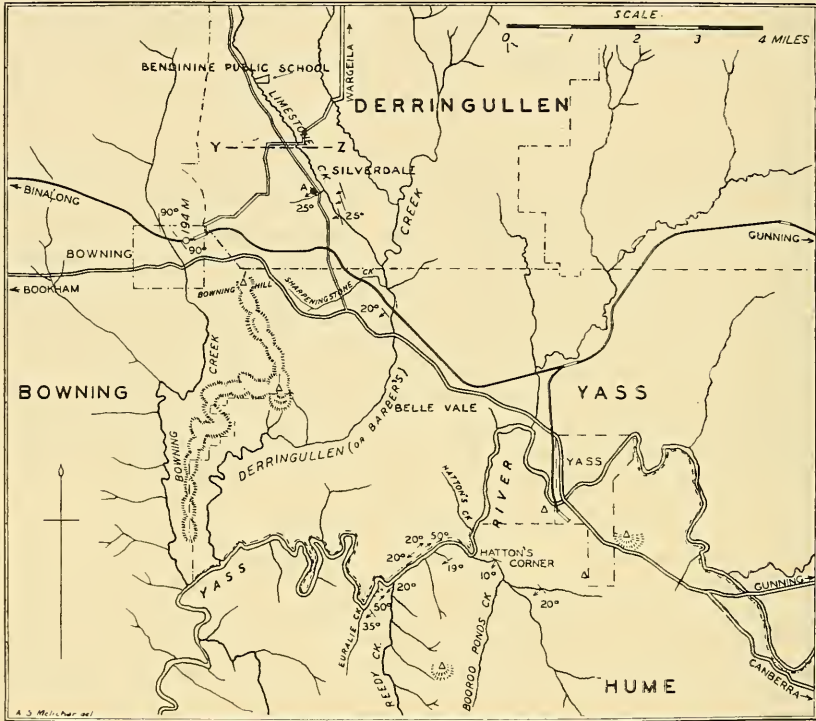
Loc. 3.—Portion 152, Parish of Manton; about centre of Portion, 50 yards north of Yass River: *Dicellograptus elegans* Carruthers, *D. cf. complanatus* Lapworth, *D. cf. moffatensis* Carruthers, *D. cf. pumilus* Lapworth, *D. cf. sextans* Hall, *D. cf. smithi* Ruedemann, *D. sp. indet.*

Loc. 4.—Portion 61, Parish of Manton, eastern half: *Dicellograptus divaricatus* Hall var. *rigidus* Lapworth, *D. cf. complanatus* Lapworth, *D. elegans* Carruthers, *D. sp. indet.*, *Diplograptus (Orthograptus) calcaratus* Lapworth var. *basilicus*

Lapw., *Climacograptus missilis* Keble and Harris, *C. tubuliferous* Lapworth, *C. sp. indet.*

Loc. 5.—Reserve, No. 43134, Parish of Morumbateman, at waterfall, about half a mile west of junction between Portions 94 and 150, Parish of Morumbateman: *Diplograptus (Orthograptus) calcaratus* Lapworth var. *basilicus* Lapw.

Loc. 6.—Portion 31, Parish of Morumbateman, near NW. corner, 50 yards south of Yass River: Graptolite fragments indeterminate.



Text-fig. A.—Topographical Map of Area between Yass and Bowning.

A = Graptolite locality.

(See Sherrard, 1936a, Text-fig. 9, for Geological Sketch-Map of the Yass and Bowning districts.)

The accompanying table attempts to correlate the graptolite species found in other parts of New South Wales, in Victoria, in Great Britain and in North America with those of Upper Ordovician age found in the Yass River district. On the whole the correlation is satisfactory. The discordant species are *D. cf. sextans*, since this species is never found higher than the Gisbornian in Victoria and in a very similar association in Great Britain and America, and *D. cf. complanatus*, which species, in Victoria, is never found outside the Bolindian. Possibly the discordance is due to the fact that the Australian *Dicellograptidae* have not been adequately described and figured. When a close examination of the forms referred to these discordant species is made, they will probably exhibit those small differences so often found in Australian species at first glance conspecific with the British.

Correlation of Upper Ordovician at Yass, N.S.W., with other Outcrops.

	Yass River	Victoria.			Britain.					N. America.			Other N.S.W. Localities.						
		Gisbortian, ¹	Bastonian, ¹	Bolindian, ¹	Zone 9, ²	Zone 10, ²	Zone 11, ²	Zone 12, ²	Zone 13, ²	Normanskill, ³	Magog, ³	Utica, ³	County Wexley, ⁴	Mandurama, ⁴	Goulburn, ⁵	Queenbeyan, ⁶	Tomingley (Peak Hill), ⁴	Talong, ⁷	
																			X
<i>Climacograptus bicornis</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
<i>C. tubuliferous</i>	X	X	X				X	X							X			cf.	
<i>C. missilis</i>	X	X	X																other sp.
<i>Diplograptus (Orthograptus) calcareatus</i>	X	X	X	X	X	X	X	X	X	X	X			spp. incert.	var.				other sp.
<i>D. (Orthograptus) calcareatus</i> var. <i>basilius</i> .	X	X	X	X	X	X	X	X	X	X	X								
<i>D. cf. truncatus</i>	X	X	X				X	X	X	X	X								
<i>Retiograptus yassensis</i>	X																		an- other sp.
<i>Dicellograptus cf. sectans</i>	X	X			X							X			sp. indet.				var.
<i>D. cf. complanatus</i>	X		X																
<i>D. divaricatus</i> var. <i>rigidus</i>	X				X	X?												cf.	X
<i>D. elegans</i>	X	X	X	X	X	X	X	X	X	X	X								
<i>D. cf. moffattensis</i>	X	X	X	X	X	X	X	X	X	X	X								
<i>D. cf. pumilus</i>	X		X				X	X	X	X	X								
<i>D. cf. smithi</i>	X																		
<i>Cryptograptus tricornis</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Notes on table: ¹ Thomas and Keble, 1933. ² Elles and Wood, 1913. ³ Ruedemann, 1908. ⁴ Hall, T. S., 1902. ⁵ Naylor, 1935. ⁶ Harris and Keble, 1929. The specimens described in this paper were obtained from Queenbeyan, N.S.W., just outside the Federal Capital Territory. ⁷ Hall, T. S., 1909, 1920.

A more precise correlation with the Victorian series, ignoring, for the time being, the discordant element, is as follows:

Loc. 1.—Top of Eastonian or base of Bolindian.

Loc. 2.—Eastonian, probably high. Limiting species, *Cryptograptus tricornis*, the extreme upward range of which is the top of the Eastonian, and a number of Eastonian-Bolindian forms.

Loc. 3.—Eastonian, probably high.

Loc. 4.—Top of Eastonian or base of Bolindian.

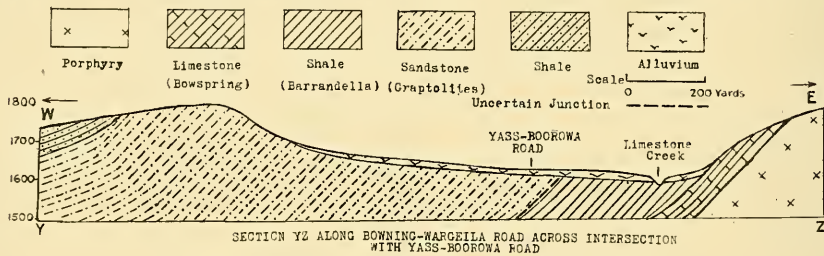
Loc. 5.—Probably Eastonian.

Loc. 6.—Indefinite.

Thomas and Keble state (1933) that the Eastonian embraces approximately the lower two zones of the Caradocian, and the Bolindian corresponds to the zone of *Pleurograptus linearis* and to the Ashgillian of Britain. It may be stated, therefore, that the Yass Upper Ordovician beds correspond to parts of the Caradocian of Britain.

Silurian Beds.

Graptolites of Silurian age occur in ripple-marked, medium-grained, greenish-brown, probably tuffaceous sandstone outcropping on the crest of a hill in Portion 34, Parish of Derringullen, County of King, included among the Lower Trilobite Beds of Mitchell (1886, 1888). The outcrop is about 300 yards west of a point on the Yass-Boorowa road, which point is three-quarters of a mile north of the Sydney-Melbourne railway crossing. This locality is known as Silverdale from a property of that name nearby. The graptolite bed dips at 25 degrees to the south-west and overlies shales dipping 25 degrees west-south-west. These



Text-fig. B.—Section along line Y-Z, Text-fig. A.

shales, which outcrop in the bed of Limestone Creek, a quarter of a mile to the east (see locality map, Text-fig. A), are richly fossiliferous, though without graptolites. They contain numerous forms identical with those in the Barrandella shales at Hatton's Corner, 6 miles to the south-south-east. Shearsby (1911) and one of the authors (Sherrard, 1936a) consider the Limestone Creek shales an extension of the Barrandella shales at Hatton's Corner, and Shearsby (1911) has given a list of the Limestone Creek fauna. Cuttings in the road from Wargeila to Bowning, which runs east and west and crosses the Yass-Boorowa road three-quarters of a mile north of the graptolite outcrop, reveal gentle south-west to west-south-west dips. As one travels along this road from a limestone outcrop (Bowspring) in the east, over the Barrandella shales in the bed of Limestone Creek, to the sandstones on the horizon of the graptolite bed, these gentle dips persist (Section Y-Z, Text-fig. B), leaving no doubt that the graptolite bed overlies the Limestone Creek beds and incidentally the Barrandella shales. There is no indication or suggestion of faulting or thrusting; the succession seems to be quite conformable and undis-

turbed. Hence the age of the Limestone Creek beds and the Barrandella shales, if Shearsby and Sherrard are right in stating that they are the same bed, may be fixed by the graptolite bed, that is, they are Silurian, probably high Wenlockian.

The brachiopods which frequently are found on the same slab as the graptolites, are all small, suggesting an unfavourable environment. *Stropheodonta davidi*, for instance, has a width of 4 mm. across the brachial valve and a length of 2.5 mm., while the type is recorded with a width of 6.0–6.3 mm. and a length of 4.8 mm. (Mitchell, 1923). While the form referred to as *Atrypa* sp. is somewhat similar to *A. pulchra* Mitchell and Dun (1920), it is very much smaller than that species, being only 3.5 mm. in width and 2.5 mm. in length in a typical specimen.

The following forms have been recognized from the graptolite bed at Silverdale: *Monograptus flemingii* (Salter), *M. cf. tumescens* Wood, *M. cf. nilssoni* (Barrande), *M. cf. vomerinus* (Nicholson), *Dictyonema* sp., *Nucleospira australis* McCoy, *Stropheodonta davidi* (Mitchell), *Atrypa fimbriata* Chapman (?), *A. sp.*, *Merista* sp., trilobite fragments, crinoid stems.

The graptolites indicate Zones 26 to 35 of the Silurian as divided by Elles and Wood (1913), which makes the bed at Silverdale containing them equivalent to the Wenlock–Ludlow junction beds of England, and to the Melbournian Series of Victoria (Chapman and Thomas, 1935; Keble and Harris, 1934).

Specimens of *Monograptus* described by T. S. Hall (1903) as "allied to *M. dubius*" were obtained by Mitchell from Belle Vale, Yass, which is a property situated between Silverdale and Hatton's Corner (see locality map, Text-fig. A).

Shearsby (personal communication) obtained a specimen identified as *Monograptus cf. vomerinus*, while quarrying operations were in progress about 1915 for a new railway bridge over Bowning Creek near Bowning Station, 2½ miles west of Silverdale (see Text-fig. A).

Species of *Monograptus* obtained near Goulburn, about 60 miles east of Silverdale (Naylor, 1935), are the only other forms of Monograptidae described from New South Wales. At that locality all species but one are characteristic of beds of Lower Silurian age.

Family DIPLOGRAPTIDAE Lapworth.

CLIMACOGRAPTUS BICORNIS (Hall). Text-fig. 1.

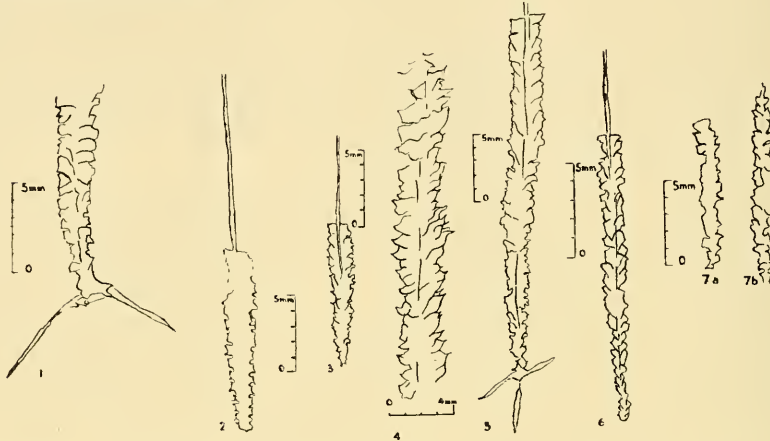
A rhabdosome 1.2 cm. in length is exposed which is incomplete distally. Its width is 1 mm. at the proximal end and 2.2 mm. where it is broken distally. The spines are very strong and conspicuous, 6 mm. in length and include an angle of 110 degrees. The sicula is inconspicuous. There are 10 thecae in 10 mm., about 1.5 mm. long and overlapping one-third of this length. Their apertural margins are situated within horizontal pouches which occupy nearly one-third the width of the rhabdosome. The ventral edges of the thecae are straight and vertical. The septum is preserved complete except at the extreme proximal end.

CLIMACOGRAPTUS TUBULIFEROUS Lapworth. Pl. xv, fig. 3; Text-fig. 2.

Rhabdosome 1.2 cm. in length, increasing in width slowly from 0.8 mm. to just over 2 cm. distally. The sicula is not seen. There are 12 thecae in 10 mm., the free edge of the theca is straight or slightly concave and the apertural margin lies within a semicircular excavation which occupies one-fifth the width of the rhabdosome. The virgula is very conspicuous, and about 0.5 mm. wide. It is prolonged 10 mm. beyond the distal extremity of the rhabdosome, within which it can be detected for a short distance. Short spines are visible on the mesial angles of some of the thecae.

CLIMACOGRAPTUS MISSILIS Keble and Harris. Text-fig. 3.

Rhabdosome not more than 1 cm. in length. Its width, less than 1 mm. proximally, increases to nearly 2 mm. distally. A short virgella is visible. The virgula can be seen in the body of the rhabdosome for one-third of its length, of which 6 mm. projects at the distal end, and is somewhat expanded in places. Thecae 10-11 in 10 mm., about 1.5 mm. long, of which one-third to one-half overlaps. The apertural margin lies within an excavation occupying one-quarter the width of the rhabdosome.



Text-fig. 1.—*Climacograptus bicornis* (Hall), Portion 24, Parish of Morumbateman. No. S.616.

Text-fig. 2.—*Climacograptus tubuliferus* Lapworth, Port. 61, Par. of Manton. No. S.591.

Text-fig. 3.—*Climacograptus missilis* Keble and Harris, Port. 24, Par. of Morumbateman. No. S.602.

Text-fig. 4.—*Diplograptus* (*Orthograptus*) cf. *truncatus* Lapw., Port. 24, Par. of Morumbateman. No. S.605.

Text-fig. 5.—*Diplograptus* (*Orthograptus*) *calcaratus* Lapworth, Port. 24, Par. of Morumbateman. No. S.602.

Text-fig. 6.—*Diplograptus* (*Orthograptus*) *calcaratus* Lapworth, var. *basilicus* Lapworth, Port 61, Par. of Manton, No. S.576.

Text-fig. 7.—*Cryptograptus tricornis* (Carruthers), Port. 1, Par. of Mundoonen. No. S.507. 7a, obverse aspect, obliquely compressed; 7b, same aspect, normally compressed, on same slab as 7a.

DIPLOGRAPTUS (ORTHOGRAPTUS) cf. TRUNCATUS Lapw. Text-fig. 4.

Rhabdosome incomplete, fragments of 2 cm. preserved, reaching a maximum width of more than 3 mm., but becoming slightly narrower distally. Thecae 10 in 10 mm., and 2 mm. long, overlap, according to aspect of preservation, is one-third or one-half of this length. The apertural margin is undulate and everted, and the overlap of one theca upon the next is very plain. Septum discontinuous.

DIPLOGRAPTUS (ORTHOGRAPTUS) CALCARATUS Lapworth. Text-fig. 5.

The rhabdosome is 3-4 cm. in length and increases in width from 1.0 mm. to 2.5 mm., which is attained about 1.5 cm. from the proximal extremity. The virgella is very conspicuous and about 4 mm. long. Strong spines, only slightly shorter, are developed on the first two thecae. The virgula is broad. It is

observable within the body of the rhabdosome and is sometimes prolonged beyond the distal extremity of the rhabdosome, though it is frequently broken off short in the specimens observed. Thecae 8-10 in 10 mm., about 2 mm. long, overlap about one-half this length. According to the aspect of preservation which is sometimes scalariform in the proximal portion and sub-scalariform distally, the thecae vary in appearance. Their outlines may be rounded or have a parallel inclination. The septum is discontinuous.

DIPLOGRAPTUS (ORTHOGRAPTUS) CALCARATUS var. BASILICUS Lapworth. Text-fig. 6.

A variety of *Diplograptus calcaratus* occurs more abundantly than the type form. It is without the prominent basal spines, and is rather narrow and compact, its maximum width being 2 mm. The rhabdosome is 2.5 cm. in length, while the virgula projects 0.5 cm. beyond the distal extremity of the rhabdosome as well as being visible within it. There are 10 thecae in 10 mm., each being about 2 mm. long and overlapping more than half this length. There is a septum.

CRYPTOGRAPTUS TRICORNIS (Carruthers). Text-fig. 7a, 7b.

Rhabdosome a thin film, 1 cm. long, and up to 1.3 mm. wide. Thecae 12-11 in 10 mm., 1 mm. long and overlapping one-half of this length, with free edge rounded off and apertural edges everted. Proximal end not seen. Figures 7a and 7b show obverse aspect, 7a, however, being obliquely compressed.

Family DICRANOGRAPTIDAE Lapw.

DICELLOGRAPTUS cf. COMPLANATUS Lapworth. Text-fig. 8.

Stipes 3-4 cm. in length diverging at angles of 270-295° from a conspicuous sicula and with short and stout lateral spines. Thecae 11-10 in 10 mm. The proximal thecae have their ventral walls inclined, but those developed after the third or fourth theca have their ventral walls straight and in some cases parallel to the dorsal margin of the rhabdosome. The thecae overlap for about one-third their length, which is up to 2 mm. Apertures open within well-marked excavations occupying nearly half the width of the stipe and one-fifth to one-third the ventral wall. Proximally the stipes are 0.7 mm. wide, but this increases abruptly to 1.0 mm. They are straight. The axil is wide and square. The sicula is generally broken in the specimens examined, but is distinct. The shape of the axil might suggest a comparison with *D. elegans*, but this is precluded by the shape of the thecae and the straightness of the stipes. When preserved in a scalariform aspect the stipes are narrower and the angle of divergence is larger.

DICELLOGRAPTUS DIVARICATUS Hall var. RIGIDUS Lapworth. Text-fig. 9.

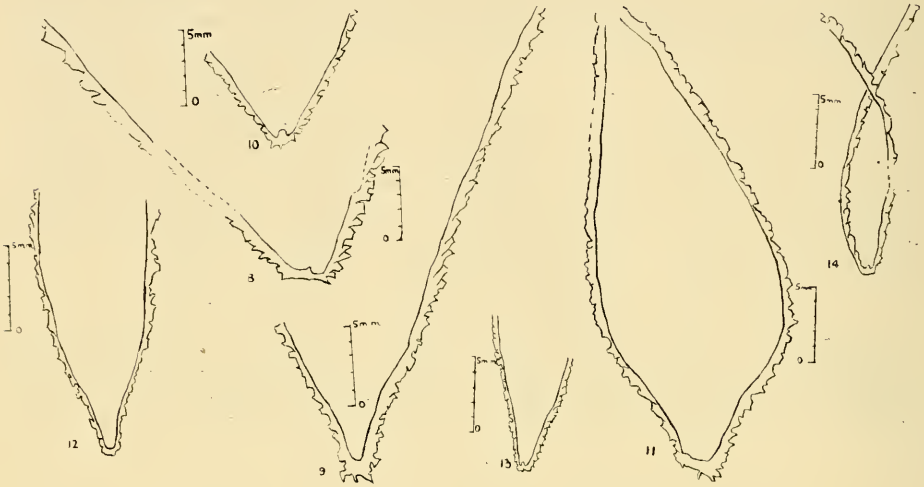
Stipes more than 3 cm. long, with slight convex, dorsal curvature. The stipes are 1.0 mm. broad at the proximal extremity and become no broader distally. The rhabdosome appears to be thickened in the axillary portion. The axil is pointed, the angle of divergence being 320°. The sicula is blunt. The virgella and lateral spines are conspicuous. The thecae are 10 in 10 mm. and about 1 mm. or more in length, overlapping one-half to one-third of this length. They commonly open within an excavation occupying one-half the width of the stipe.

DICELLOGRAPTUS cf. SEXTANS Hall. Text-fig. 10.

Stipes straight or with slight curvature of ventral margin distally, 1 cm. long, 0.7 mm. wide distally and 0.5 mm. proximally, diverging at 295-305° from a blunt node-like sicula, which is large in some cases. Axil pointed; strong, lateral spines present in some specimens, though sometimes the sicular end is obscure. Thecae



12 in 10 mm., and up to 1.5 mm. long, overlapping not more than a quarter of their length, outer wall curved. Apertural excavations sometimes semi-circular, sometimes pouch-like, one-third to one-half the width of the stipe.



Text-fig. 8.—*Dicellograptus* cf. *complanatus* Lapworth, Port. 1, Par. of Mundoonen. No. S.533.

Text-fig. 9.—*Dicellograptus* *divaricatus* Hall var. *rigidus* Lapworth, Port. 61, Par. of Manton, No. S.581.

Text-fig. 10.—*Dicellograptus* cf. *sextans* Hall, Port. 152, Par. of Manton. No. S.554.

Text-fig. 11.—*Dicellograptus* *elegans* Carruthers, Port. 61, Par. of Manton. No. S.577.

Text-fig. 12.—*Dicellograptus* cf. *moftatensis* Carruthers, Port. 152, Par. of Manton. No. S.560.

Text-fig. 13.—*Dicellograptus* cf. *pumilus* Lapworth, Port. 152, Par. of Manton. No. S.564.

Text-fig. 14.—*Dicellograptus* cf. *smithi* Rædemann, Port. 152, Par. of Manton. No. S.565.

DICELLOGRAPTUS ELEGANS Carruthers. Text-fig. 11.

Stipes up to 3.5 cm. in length, showing strong and graceful curvature, diverging at large angles, 300–320°, from a faint sicula. The axil is square. Stipes 0.6 mm. wide proximally, which increases gradually to 0.8. Lateral spines observable conspicuously in some specimens. Thecae 11–9 in 10 mm. overlapping about a quarter of their length, which is about 1.5 mm., having a curved ventral wall and, in a profile view, an apertural excavation, which is about half the width of the stipe.

From a square axil nearly 1.5 mm. across, the stipes diverge but slightly for about 1 mm., then open with a graceful concave dorsal curvature until they are approximately 1 cm. apart, which distance is maintained for about 5 mm., when the stipes gently curve towards one another again, just meeting in unbroken specimens, at about 3.5 cm. perpendicularly from the axil in a large specimen. These specimens show the proximal double curvature "eminently characteristic of the species" and, like it, are ultimately convexly curved, and strongly resemble the plate of Carruthers' type specimen (Elles and Wood, 1904, Pl. xxiii, fig. 2a).

DICELLOGRAPTUS cf. MOFFATENSIS Carruthers. Text-fig. 12.

Stipes slender, 2 cm. in length, slightly curved, sub-parallel for 3 mm. proximally, then they diverge at 320° , converging slightly at the distal extremity. There is only a slight increase in width of the stipes to a maximum of 0.7 mm. Thecae 12 in 10 mm., overlapping one-quarter of their length of 1 mm. The free ventral wall is parallel to the dorsal margin of the stipe. Wide, semi-circular apertural excavations, occupying nearly half the width of the stipe. It is a small, fine form.

DICELLOGRAPTUS cf. PUMILUS Lapworth. Text-fig. 13.

The stipes are a little more than 1 cm. in length, with a uniform width of 5 mm. and diverge at about 335° from a very conspicuous sicula. A somewhat scalariform aspect of preservation probably makes the stipes appear narrower than they are. The axil is wide and the stipes curve very gently, first with a concave dorsal curvature, which is later reversed. The thecae are 12 or more in 10 mm., and overlap about half their length of 1 mm., with their outer walls slightly curved. The sicula, though very distinct, is broken. Figure No. 3c in Plate XXI of the Monograph of British Graptolites (Elles and Wood, 1904), where the angle of divergence is 330° , is closely comparable with this form, which has, however, finer stipes.

DICELLOGRAPTUS cf. SMITHI Ruedemann. Text-fig. 14.

Stipes up to 2 cm. long, of nearly uniform width, about 0.6 mm. wide. Thecae 10 in 10 mm. Stipes twisted near the sicula, which is noticeable, so that the ventral side of one stipe faces the dorsal side of the other, after diverging at an angle of 330° from a pointed axil. Subsequently the stipes converge and cross one another. The thecae are 1 mm. long and overlap one-quarter of their length. The forms compared with this species are precisely similar to specimens figured by Ruedemann (figs. 5 and 6, Pl. 19, Ruedemann, 1908).

Family GLOSSOGRAPTIDAE Lapworth.

RETIORAPTUS YASSENSIS, n. sp. Plate xv, fig. 1.

Rhabdosome with sub-parallel margins, widening rapidly to a maximum breadth of 2 mm. without spines, 4 mm. with spines, which is maintained throughout. The maximum length observed is 3 cm. Test continuous over all but distal portion of rhabdosome, thickest in proximal portion, where it obscures the lists, but becoming more attenuated towards the distal end and apparently extremely attenuated or not present in the most distal thecae. In these thecae it is strengthened by lists into complete clathria with rhomboid meshes forming conspicuous ventral lattices. Sicula scarcely visible. Thecae alternate, proximal ones with their ventral and apertural lists produced into stout, arcuate spines which, however, become less conspicuous and almost disappear distally. Thecae 11-9 in 10 mm. The septal strand in the obverse aspect is well defined, straight and produced for a short distance beyond the rhabdosome.

Remarks.—*R. yassensis* resembles *R. pulcherrimus* Keble and Harris (Plate xv, fig. 2). Apart from any differences in the meshwork, however, it can be distinguished from Keble and Harris's species by its rapid widening in its proximal portion and its stouter arcuate spines. The septal strand in *R. yassensis* is also more conspicuous. *R. pulcherrimus* is a much longer form than *R. yassensis*.

Associated graptolites: *Diplograptus* (*Orthograptus*) *calcaratus* Lapw. var. *basilicus* Lapw., *D.* cf. *truncatus* Lapworth, *Climacograptus missilis* Keble and

Harris, *Cryptograptus tricornis* Carruthers, *Dicellograptus cf. complanatus* Lapworth, *D. cf. sextans* Hall.

Horizon.—Upper Ordovician, Eastonian, high in that series.

Locality.—Portion 1, Parish of Mundoonen, 200 yards north of Morumbateman road junction (loc. 2).

Family MONOGRAPTIDAE Lapworth.

Genus MONOGRAPTUS Geinitz, restricted.

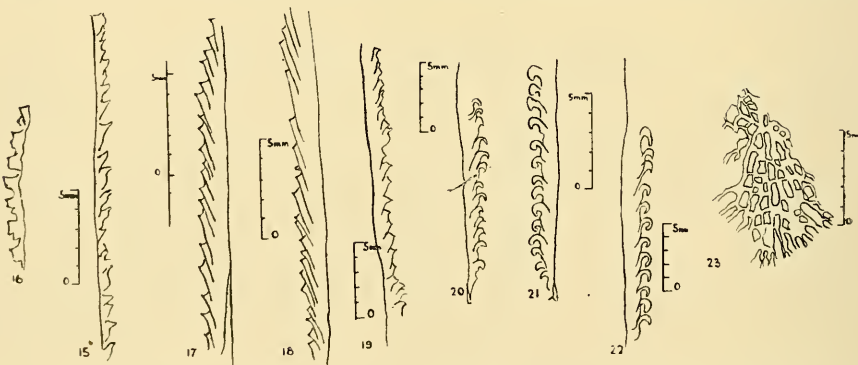
MONOGRAPTUS cf. NILSSONI (Barrande). Text-figs. 15, 16.

Rhabdosome fragmentary, up to 2 cm. in length, slight convex dorsal curvature in the distal fragments which are found preserved in relief, proximal end not observed. Breadth 1 mm. Thecae 8 in 10 mm., show sigmoidal curvature, 2 mm. long and 0.4 mm. wide. Overlap very slight, angle of inclination 20°, apertural margin slightly concave, but generally at right angles to the direction of the rhabdosome. The thecae appear almost isolated when preserved in high relief (see Text-fig. 16), but this is probably due to the matrix not being completely removed.

Associates: *Nucleospira australis* McCoy, *Atrypa* sp., *Stropheodonta davidi* Mitchell.

MONOGRAPTUS cf. TUMESCENS Wood. Text-figs. 17, 18.

Rhabdosome fragmentary, up to 3.5 cm. long (proximal end not observed), straight, maintaining a width of 1.7–2 cm. throughout. Sicula not seen. Thecae uniform in shape, becoming rather longer distally. Thecae 10–8 in 10 mm., long in proportion to their width, 2–3 mm. long, and 0.4–0.5 mm. broad. Overlap slightly more or slightly less than half. Thecae sometimes widening towards the apertural margin, which is concave in section, produced into a more or less distinct denticle. The angle of inclination is 20–25°, which is the angle seen in figures of *M. tumescens* (figure 12a, Plate xxxvii, British Graptolites, Part VIII, Elles and



Text-fig. 15.—*Monograptus cf. nilssoni* (Barrande), Port. 34, Par. of Derringullen. No. S.134.

Text-fig. 16.—*Monograptus cf. nilssoni*. Reverse of Fig. 15.

Text-figs. 17, 18.—*Monograptus cf. tumescens* Wood, Port. 34, Par. of Derringullen. Nos. S.31, S.133.

Text-fig. 19.—*Monograptus cf. vomerinus* (Nicholson), Port. 34, Par. of Derringullen. No. S.9.

Text-figs. 20–22.—*Monograptus flemingii* (Salter), Port. 34, Par. of Derringullen. Nos. S.333, S.73, S.334.

Text-fig. 23.—*Dictyonema* sp., Port. 34, Par. of Derringullen. No. S.312.

Wood, 1910). This angle of inclination prevents a comparison with *M. vulgaris* whose angle of inclination is 35–40°, which angle is shown in all figures of the species in the same Monograph (Elles and Wood, 1910).

Associate: *Stropheodonta davidi* Mitchell.

MONOGRAPTUS cf. VOMERINUS (Nicholson). Text-fig. 19.

Rhabdosome fragmentary, up to 3 cm. in length, fragments generally straight, breadth 1 mm. when preserved in high relief, 1.5 mm. when seen in cast, sicula not seen. Thecae 11 in 10 mm., slightly more than 1 mm. in length, about twice as long as wide, overlapping seldom more than a quarter of this length. The aspect of the thecae seen in relief differs from that seen in cast. In the latter case the thecal boundaries show an almost spiral curvature, and in the former a less pronounced ogee curvature.

Associates: *Atrypa* sp., *Stropheodonta davidi* Mitchell.

MONOGRAPTUS FLEMINGII (Salter). Pl. xv, figs. 4, 5; Text-figs. 20, 21, 22.

Rhabdosome incomplete, 2 cm. in length, straight or with slight dorsal curvature near the proximal end. Average width 1.7 mm. with a maximum of 2 mm. A width of 1.7 mm. is shown by the specimens figured here, and at an equivalent distance from the proximal extremity, viz., the fourteenth theca, in figures of *M. flemingii* in the Monograph of British Graptolites (Fig. 5d, Pl. xlii, Elles and Wood, 1912). A sicula is not often preserved, but, when seen, has a length of 1.6 mm. Thecae 12–9 in 10 mm. They show ogee curvature and become narrower towards their apertural extremities. They are about 2 mm. long, and up to 7 times as long as wide. Up to one-third of the theca itself may be involved in a hook, which occupies less than half the breadth of the rhabdosome, usually about two-fifths, the thecal overlap is from one-quarter to two-thirds of the total length. The hooks may be called beak-like rather than claw-like, but the mode of preservation and angle from which the specimen is examined cause a difference in the appearance of the ventral margin, so that the hooks are not perceptible at all from one angle. The inter-thecal line is strongly marked. The fragmentary state in which the graptolites are found is characteristic of *M. flemingii*, while their straightness and stiffness preclude their reference to *M. riccartonensis* or *M. uncinatus* var. *orbatus*, which are characterized by a "limp, broken-backed appearance" (Elles and Wood, 1912).

Associates: *Nucleospira australis* McCoy, *Stropheodonta davidi* Mitchell, *Atrypa* sp.

Acknowledgements.

The authors wish to thank Professor L. A. Cotton, M.A., D.Sc., of the University of Sydney, for granting facilities for work at the Geological Department of the University. Mr. C. W. Brazenor, Mammalogist to the National Museum, Melbourne, has rendered them great assistance in photography. The courtesy of Mr. F. W. Booker, M.Sc., of the Geological Survey of New South Wales, and of Mr. H. O. Fletcher, of the Australian Museum, Sydney, in making available type specimens of graptolites and brachiopods, respectively, for comparison is also much appreciated. One of the authors (K.M.S.) is also indebted to Miss Yeo, of Yass, for her suggestion of the likelihood of the occurrence of graptolites at Silverdale.

References.

CHAPMAN, F., and THOMAS, D. E., 1935.—The Geology of Victoria, the Silurian. *Hand-book Aust. N.Z. Assoc. Adv. Sci.*, Melbourne, 1935, p. 107.

- DUN, W. S., 1897.—Occurrence of Lower Silurian Graptolites in New South Wales. *Rec. Geol. Surv. N.S.W.*, v, pt. 3, 1897, p. 124.
- ELLES, G. L., and WOOD, E. M. R., 1904-1913.—A Monograph of British Graptolites. Part IV, *Pal. Soc.*, lviii, 1904; Pt. V, *ibid.*, lx, 1906; Pt. VI, *ibid.*, lxi, 1907; Pt. VII, *ibid.*, lxii, 1908; Pt. VIII, *ibid.*, lxiv, 1910; Pt. IX, *ibid.*, lxvi, 1912; Pt. X, *ibid.*, lxvii, 1913.
- HALL, T. S., 1902a.—Graptolites of New South Wales. *Rec. Geol. Surv. N.S.W.*, vii, Pt. 2, 1902, p. 49.
- , 1902b.—On the Occurrence of *Monograptus* in New South Wales. *Proc. Linn. Soc. N.S.W.*, xxvii, 1902 (1903), p. 654.
- , 1909.—Notes on a Collection of Graptolites from Tallong, New South Wales. *Rec. Geol. Surv. N.S.W.*, viii, Pt. 4, 1909, p. 339.
- , 1920.—On a further collection of Graptolites from Tolwong, New South Wales. *Rec. Geol. Surv. N.S.W.*, ix, Pt. 2, 1920, p. 63.
- HARRIS, W. J., and KEBLE, R. A., 1929.—Collection of Graptolites from the Federal Territory. *Proc. Roy. Soc. Vict.*, n.s., xlii (i), 1929, p. 27.
- KEBLE, R. A., and HARRIS, W. J., 1925.—Graptolites from Mt. Easton. *Rec. Geol. Surv. Vict.*, iv, pt. 4, 1925, p. 507.
- , 1934.—Graptolites of Victoria, New Species. *Mem. Nat. Mus. Vict.*, viii, 1934, p. 166.
- MCCOY, F., 1877.—Palaeontology of Victoria. *Prod. Pal. Vict.*, Dec. v, 1877, p. 19.
- MITCHELL, J., 1886.—Geology of Bowning. *Proc. Linn. Soc. N.S.W.*, i (2nd Series), 1886, pp. 1059 and 1193.
- , 1888.—Geological Sequence of the Bowning Beds. *Rept. Aust. Assoc. Adv. Sci.*, i, 1888, p. 291.
- , 1923.—Strophomenidae from the fossiliferous Beds of Bowning, N.S.W. *Proc. Linn. Soc. N.S.W.*, xlvi, 1923, p. 465.
- and DUN, W. S., 1920.—The Atrypidae of New South Wales. *Proc. Linn. Soc. N.S.W.*, xlv, 1920, p. 266.
- NAYLOR, G. F. K., 1935.—The Palaeozoic Sediments near Bungonia. *Journ. Roy. Soc. N.S.W.*, lxix, pt. 2, 1935, p. 123.
- RUEDEMANN, R., 1908.—Graptolites of New York, Pt. 2. *N.Y. State Mus. Mem.*, 1908, 540 pp.
- SHEARSBY, A. J., 1911.—The Geology of the Yass District. *Rept. Aust. Assoc. Adv. Sci.*, xiii, 1911, p. 106.
- SHERRARD, K., 1934.—Exhibit to Geological Section, Royal Society of New South Wales. *Journ. Roy. Soc. N.S.W.*, lxviii, 1934, p. xlvi.
- , 1936a.—Structural Geology and Petrology of . . . Yass, N.S.W. *Proc. Linn. Soc. N.S.W.*, lxi, 1936, p. 131.
- , 1936b.—Exhibit to Linnean Society of New South Wales. *Proc. Linn. Soc. N.S.W.*, lxi, 1936, p. 1.
- THOMAS, D. E., and KEBLE, R. A., 1933.—Ordovician and Silurian Rocks. *Proc. Roy. Soc. Vict.*, n.s., xlv, Pt. 2, 1933, p. 33.

EXPLANATION OF PLATE XV.

Fig. 1.—*Retiograptus yassensis*, n. sp. Complete rhabdosome obverse aspect. Port. 1, Par. of Mundoonen. No. S.501.

Fig. 2.—*Retiograptus pulcherrimus* Keble and Harris. Proximal portion. Yarra Track, Victoria. No. 26691, Nat. Mus. Melb.

Fig. 3.—*Climacograptus tubuliferous* Lapworth, Port. 61, Par. of Manton, No. S.591.

Figs. 4, 5.—*Monograptus flemingii* (Salter), Port. 34, Par. of Derringullen. Nos. S.233, S.236.

(Where not otherwise stated, specimens are in the collection of one of the authors—K.M.S.)